The Sixth Stage: Mastery

Mohsin Mukhtar BS, BA

Richard B. Gunderman MD, PhD

One of the most widely influential models of skills acquisition was introduced by two brothers from Terre Haute, Indiana, both of whom later joined the faculty of the University of California, Berkeley. Hubert Dreyfus, who passed away in April of 2017, was not only a professor of philosophy and an expert on the German philosopher Martin Heidegger, but he also made important contributions to the understanding of artificial intelligence. Stuart Dreyfus completed a PhD in applied mathematics and helped to advance the field of computer programming; he is now a professor emeritus of industrial engineering and operations research at Berkeley. Together, the Dreyfus brothers, who were on contract to the US Air Force, co-authored in 1980 an 18-page report detailing the role of formal instruction and practice in skills acquisition (1), which they subsequently developed in their 2000 book entitled Mind Over Machine (2).

Five Stages

The original Dreyfus skills acquisition model consisted of five stages, to which they later added a sixth. Although it is primarily the final and highest stage on which we wish to focus in this article, it is important first to review each of the first five stages. The first stage is novice. At this stage, learners lack any experience for recognizing the context in which they operate, and they function strictly by rules. For example, a novice at chest radiograph interpretation might be taught to use the cardiothoracic ratio to assess for cardiomegaly, according to the rule that a cardiothoracic ratio over 0.5 is abnormal, without any understanding of processes such as pericardial effusion that can mimic cardiomegaly or any appreciation for the differential diagnosis of such a finding. Hence, novices should be evaluated largely by whether they know and follow the rules.

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The second stage of the Dreyfus model of skills acquisition, which the authors added later, is advanced beginner. At this stage, learners can begin to perceive features of the situation in which they find themselves and are no longer blindly applying rules. However, they are unable to distinguish between the relative importance of these different features and tend to treat them all as equally significant. For example, students of radiology might learn to assess not only heart size but also opacities in the lungs, pleural effusions, and the presence or absence of pneumothorax, thereby beginning to produce a comprehensive report. However, they are unable to determine which of these findings might be of more importance than another, and they cannot combine the findings into a meaningful overall assessment, such as a diagnosis of congestive heart failure.

The third stage of the Dreyfus model is competence. As learners develop competence, they learn to apply guidelines to features of the situation in which they find themselves. At this level, learners are able to follow these guidelines to determine what rules to follow in different situations. For example, a student of chest radiography might learn that the cardiothoracic ratio is helpful only in cases where the patient is upright, the lungs are well inflated, and a posteroanterior radiograph is obtained. Before measuring the cardiothoracic ratio, such learners would inspect a radiograph to determine whether it met these criteria and then follow the appropriate guideline for determining whether to apply the rule. Only at this level can learners be said to have a meaningful practical sense of what they are actually doing.

The fourth stage is proficiency. At this stage, learners are able to perform appropriately in a wide variety of real-world situations, and they understand how what they are doing is contributing to the achievement of a long-term goal, such as diagnosing disease and restoring health. They can also determine which aspects of the situation are more or less relevant to the achievement of this goal. Proficient radiology learners can dictate a whole chest radiograph report, arranging its elements to provide the referring physician with an ordered set of findings, conclusions, and recommendations. If some aspects of the situation change, such as the patient's age or underlying medical condition, the

proficient learner can respond appropriately, modifying the approach to meet the demands of the particular situation at hand.

The fifth stage is expertise. Up to this point, learners have been operating with a principle, such as a rule, guideline, or maxim to guide their performance in connecting the general aspects of knowledge to the particular situation. At the level of expertise, however, learners have become so experienced that they are able to diagnose the situation and respond appropriately to it on an intuitive basis. Radiologists are functioning not by following algorithms but through pattern recognition, and different kinds of patterns are intimately linked to different kinds of responses. Radiology experts can largely dispense with search patterns and mnemonics and simply know what they are seeing when they see it. This is not to say that experts cannot be stumped or that they never fall back on principles, but such situations are significant precisely because they are exceptional.

The Sixth Stage

The sixth and highest stage of skills acquisition, and the one on which we wish to focus here, is mastery. At this level, radiologists transcend their usual high level of performance, achieving a state of intense absorption in their work. They no longer pay attention to rules and even to the performance itself, allowing "all the mental energy previously used in monitoring their performance to go into producing almost instantaneously the appropriate perspective and its associated action" (p. 14) (2). The work of radiologists begins to resemble something more akin to an art than a process. In a sense, mastery is not so much a level of skills acquisition as a highly desirable state in which to work. Experts are sometimes able to enter into the state of mastery when they perform at their best in a completely unselfconscious fashion.

Perhaps the most notable feature of mastery is its connection to style. Just as most experienced viewers of art can readily recognize a painting as a Van Gogh, or at least painted in the style of Van Gogh, so too masters have a distinct style. Consider another analogy drawn from tennis. Spectators at a tennis match could pay attention to nothing but the course of the ball, never noticing the players who were

striking it. Part of the charm of tennis played at its highest level, however, is the fact that each player has a distinctive style. For example, Roger Federer and Rafael Nadal are both experts at tennis, capable of defeating virtually any other player in the world, but when each is performing at his best, he looks quite different from the other. They possess a high level of expertise, but their approach to the game manifests a distinct style.

In beholding a master at work, we are witnessing not just the highest possible level of skill acquisition but a distinctive manifestation of expertise. Whether at the view station, in the interventional suite, or in the classroom or laboratory, individuals who have mastered radiology exhibit such a style. Asked to name the teacher, role model, or colleague they admire most, many radiologists can think of a particular person, and when asked to describe such individuals, they tend not to talk about low miss rates or high levels of productivity, but in terms of style. Such masters do much the same things as everyone else, but they do them in a special way. In this style is reflected not only a high level of skill but the master's character and professional vision.

Recognizing this sixth level of mastery is immensely significant. For one thing, too much of education is focused on the achievement of mere competence. The Accreditation Council for Graduate Medical Education (ACGME) has defined its educational objectives in terms of competencies (3). By adopting a competency-based approach to education, we may be setting both educators' and learners' sights too low and introducing unnecessary constraints on performance. When any educational program is premised on the view that competence is the highest level learners need to reach, it will naturally adopt approaches to education and learning that aim at competence. Instead we need to recognize that competence is not the end of education, and that learners need to be prepared as though it represents just a way station on the path to a higher and ultimately more fruitful and fulfilling level of performance.

Our systems of assessment—particularly the ubiquitous multiple-choice examination question—work reasonably well for learners aiming at the level of advanced beginner or perhaps competence, but they perform remarkably poorly at even recognizing—let alone assessing—the existence of mastery. An

approach premised on competence is often justified by the need to identify learners who do not meet minimum standards, but it can lead many learners to regard scores on such tests as the best indicators of how well they are performing. What we need are approaches to assessment that recognize learners as potential experts and even masters. Given the appropriate kind of encouragement, learners may develop far beyond competence to levels that transcend the skills of even those responsible for teaching and assessing them. To foster such high levels of attainment, we need to see medical students, residents, and fellows as potential masters.

If learners are to develop the dimension of style associated with mastery, they need opportunities during training to stretch their wings and attempt to fly. Such opportunities might include teaching other learners, conducting research, and serving professional organizations, among many other possibilities. The key is not to promote conformity to rules and guidelines, but to encourage the development of distinctive areas of expertise, perhaps in areas relatively unknown to many or even all members of the faculty. We cannot expect learners who have been marinated in a culture of competence and conformity for 15 or 20 years to suddenly begin developing their own style. To promote mastery, we must permit and even encourage exploration and creativity. By so doing, we can foster a culture that not only weeds out deficiencies but actively promotes the highest levels of excellence.

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